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ABSTRACT

Recent studies suggest the existing applications of high technology to the improvement of schooling are relatively ineffective. Their potential may be better realized when newer, more powerful technology is introduced and educators learn to make it succeed by sorting out the factors and aspects of effective schooling, learning, and teaching that are best fostered by technology and those best supported by humans. To do that, experiments must be designed, performed, and studied using both electronic (high tech) and human (high touch) means to deliver the effectiveness and productivity factors. Also required is collaboration by all members of the educational research community. Six references are listed. (DCS)

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High Tech : High Touch

The Agony and Ecstasy of School District-Based Educational Improvement Effects

Summary of Remarks Presented
at the 1985 American Educational
Research Association Annual Meeting

Walter E. Hathaway
Portland (OR) Public Schools

April 1985

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The advent of low cost microcomputers in the late '70's and early '80's was greeted by a shudder of ecstasy by the education community. Here at last was the magic tool that would allow us to effectively individualize instruction, redeeming the educationally disadvantaged, liberating the talented and gifted, and advancing the average as far as they could go. It would also free teachers from data collection and maintenance activities that kept them from the reality and satisfaction of teaching, while providing them and other support and administrative staff easily accessible information they needed to do their jobs better and more enthusiastically. Moreover, the microcomputer was just the vanguard of a whole armada of high tech marvels such as video disks, satellites, robots, communications networks, etc., that would further lift us up and link us together into one, great, self-renewing, learning society.

No wonder that we rushed to raid our Chapter I coffers and our state and local disadvantaged funds to purchase and put in place this panacea, since here was where the greatest need and opportunity was. No wonder PTA's rushed to compete with one another in bake sales and other bacchanals aimed at forcing the hands that controlled district purse strings. Soon, even precious general fund dollars yielded to the onslaught and found themselves transformed into hardware, software, inservice, maintenance contracts, and new administrative and support structures.

Thus began a parade into our schools of high tech flora and fauna including Pets, Personals and Apples; whereupon previously unprepared school staffs rose valiantly to the challenge of domesticating these new and mysterious machines to the task of improving learning, teaching and schooling; well, at least some of them did, some of the time.

Like every major campaign to revolutionize education, this latest one has been accompanied by the usual panoply of camp followers, including researchers and evaluators like myself. Much of our work thus far has focused on comparisons of the effects of hardware and software systems to those of more traditional person-centered programs involving aides, tutors and other touching as well as instructing means. My goal today is to share some of our admittedly preliminary but largely agonizing appraisals of the degree to which the initial hopes for the promise of the application of high tech to education has thus far been left unrealized. I will also indicate how what we have learned might be linked to the results of research on effective learning, teaching and schooling to help us pursue a broader and more integrated set of aspirations uniting humans and machines in systems balancing high tech and high touch. Finally, I will speculate on how an even newer and more powerful generation of technology, combined with the lessons learned by study of our early efforts, may permit us to realize a more realistic but authentically promising version of our original high tech dream through an integration with a more traditional but refined commitment to high touch in education as well as high tech.

Evaluation of High Tech in Portland

In the fall of 1983, my staff and I in Research and Evaluation in the Portland, Oregon Public School system completed our first annual evaluation of "Computer Use in (Our) Schools." This 137-page document reviewed the evidence of the success and failure of our attempts to that point in time to use available high technology to improve the effectiveness and efficiency of schooling and instruction using Computer-Assisted Instruction, Computer-Managed Learning, Computer Literacy Programs and Computer Management Strategies for over two years. The recommendation section of that report

begins as follows: "Our existing efforts to use Computer-Assisted Instruction in the elementary schools are overall a failure. The evidence is that Computer-Assisted Instruction, as implemented for the last two years, is not an effective supplement to instruction in the basic skills. The evidence suggests termination of this program." Similar but not quite as negative results were reported for our Computer-Managed Instruction program.

These controversial conclusions were imbedded in a further and less noted set of generally positive findings on the overall success of our efforts in the areas of Computer Literacy and Computer Management.

The facts, documented exhaustively in the preceding pages of the report, showed that none of our attempts to raise achievement levels, especially of our educationally disadvantaged students, through the use of existing in-school microcomputer and minicomputer based instructional and individual support systems had made a positive difference in student learning. It is important to note that the systems found most wanting were existing commercially available, supplemental, basic skills computer-assisted drill and practice packages that substituted time at a terminal for time in human interaction. The most successful "high-tech" intervention was one that utilized the computer as an aid to diagnosing students' specific learning needs and to prescribing specific objectives, activities and materials for a sympathetic, supportive human tutor to work on with the student, thus combining high tech and high touch.

These results have led us to further evaluation and searching along the lines sketched below.

What Others Have Found

For a while we found ourselves nonplussed by our apparent inability as a district to realize the promise of computer technology for school improvement. More recently, a number of national studies have shown we are not as alone as we initially feared.

Space and time will not permit summarizing all the recent studies confirming our initial district finding on the relative ineffectiveness of existing applications of higher technology to the improvement of schooling. Two national studies do, however, stand out as representative of an emerging national research and evaluation consensus in this area.

The 1984 Stanford study by Henry Levine, Gene Glass and Gail Meister came out solidly pro high touch in the high tech vs. high touch derby. In the Stanford study, the high touch activity of peer tutoring was found to be the most cost effective of four approaches to increasing math and reading achievement, far outstripping computer-assisted instruction, reducing class size and increasing instructional time. This report states that:

> In some ways the results are surprising. For example, a traditional and labor-intensive approach, peer tutoring, appears to be far more cost-effective than a widely used CAI approach.

This finding is consistent with our results in Portland in which human tutors significantly outperformed electronic ones.

A second national study or rather set of studies consists of the work of Herbert Walberg and his associates on the factors contributing most to productivity in America's schools. In Walberg's work he has both conducted

original studies as well as reviewed thousands of relevant studies of academic learning over the last half century. The results of these analyses are summarized in Table 1. The asterisked methods are those I have identified as high touch in the sense of requiring as an essential component direct human teacher to human student interaction. As perusal of the figure indicates, most of the higher ranked factors are of this kind whereas Computer-Assisted Instruction ranks 18th, well into the bottom half of the list.

Table 1

Instructional Quality and Time Effects on Learning
(Adopted from Walberg, 1984, p. 24)

	Method	Effect	Size
1	*Reinforcement	1.17	XXXXXXXXXXX
2	Acceleration	1.00	XXXXXXXXX
3	Reading Training	.97	XXXXXXXXX
4	*Cues and Feedback	.97	XXXXXXXXX
5	Science Mastery Learning	.81	XXXXXXXX
6	*Cooperative Learning	.76	XXXXXXX
7	Reading Experiments	.60	XXXXXX
8	*Personalized Instruction	.57	XXXXX
9	*Adaptive Instruction	.45	XXXX
10	*Tutoring	.40	XXX
11	*Individualized Science	.35	XXX
12	*Higher-Order Questions	.34	XXX
13	*Diagnostic Prescriptive Methods	.33	XXX
14	*Individualized Instruction	.32	XXX
15	*Individualized Mathematics	.32	XXX
16	New Science Curricula	.31	XXX
17	*Teacher Expectations	.28	XXX
18	Computer Assisted Instruction	.24	XX
19	Sequenced Lessons	.24	XX
20	Advance Organizers	.23	XX
21	New Mathematics Curricula	.18	XX
22	Inquiry Biology	.16	XX
23	Homogeneous Groups	.10	X
24	Class Size	.09	X
25	Programmed Instruction	-.03	-.
26	Mainstreaming	-.12	-X.

Note: The X symbols represent the sizes of effects in tenths of standard deviations.

Lessons From Educational Effectiveness Research

Local and national studies indicating the relative failure of high tech applications thus far to bring about the promised revolution in school performance raise the questions of whether high tech can't work as we hoped, whether the current state of the art is too limited, whether we haven't yet learned how to make it succeed, or some combination of the last two, as I believe.

Research on effectiveness in education has taught us what in theory we must do to establish a learning environment that will help every child learn as much as he or she can as effectively and efficiently as possible, i.e.,

- The student's current, most pressing learning needs vis-a-vis well planned curriculum must be identified.

- The student must be helped to set clear, relevant, attainable learning objectives to meet those needs.

- The student must be expected to succeed in attaining the learning objectives and must be helped to want to learn them.

- The student must receive individualized and personalized instruction directly related to the learning objectives designed to meet his or her current learning needs.

- The student must be helped to use the time allocated for instruction to work intently and seriously on the task of learning.

- The student must be assisted to know when he or she has succeeded and when not and must experience a reinforcing sense of accomplishment and achievement as a result of knowledge of success.

- The student must receive and return a sense of caring, personal concern, interest, respect and commitment which provides the psychological support necessary to want to learn and to work to learn, and finally

- The student must receive and accept peer, staff, parental and community support and encouragement for success in learning.

Which aspects of these now established essential ingredients of effective education can high tech help with best and which are necessarily left to the creativity and sensitivity of human teachers? Even today the computers in our classrooms can provide targeted diagnosis and prescription, immediate and responsive information feedback, and ongoing "attention" to the individual student. As the sophistication of hardware and software improve and are linked to video and sound systems, the power and attractiveness of the high tech learning situation will inevitably grow and the areas of the curriculum which it can penetrate will certainly expand.

Can and will machines replace human-to-human teaching and learning? Many such as Oakes and Schneider (1984) assure not:

> Computers, it is said, will never provide the multiplicity of modes and responses that sensitive human teachers have at their fingertips. They will never be able to respond appropriately to the divergence in students' creative output, to weigh

> differences of opinion, to interpret questions of values, or to ferret out a complicated thought process. Computers will never communicate the joy of discovery and the pleasure in helping someone learn. Teachers will always be required for those subtle and complex interactions that are at the heart of the teaching/learning process.

Perhaps, therefore, the great lack of current efforts at applying high tech is that there has been little systematic effort at tracing the interactions and interdependencies that stretch from the magic moment of mastery of a particular cognitive learning task by an individual learner back through the key supportive interventions by a teacher to foster that moment and even farther back to the way the school functions as a social organization to support both teachers and learners. The necessary next key step in realizing the promise of high tech for education may be a sorting out of the factors and aspects of effectiveness that are best fostered by information communicating technology and those that are best supported by sympathetic human helpers. Below I begin that sorting out process.

Factors of Effective Learning

In the act of learning, three major sets of factors must interact to produce the ideal learning environment sketched earlier. These are: the characteristics that the learner brings to the learning situation, the characteristics of the learning task, and the activities of the learner. They are depicted in Figure 1. Learner characteristics include: general ability or aptitude, previous related learning, learning skills, and motivation (i.e., interest, attention and belief that he or she can learn). It is these sorts of factors that Coleman and others suggested were most strongly influenced by family background and socio-economic status.

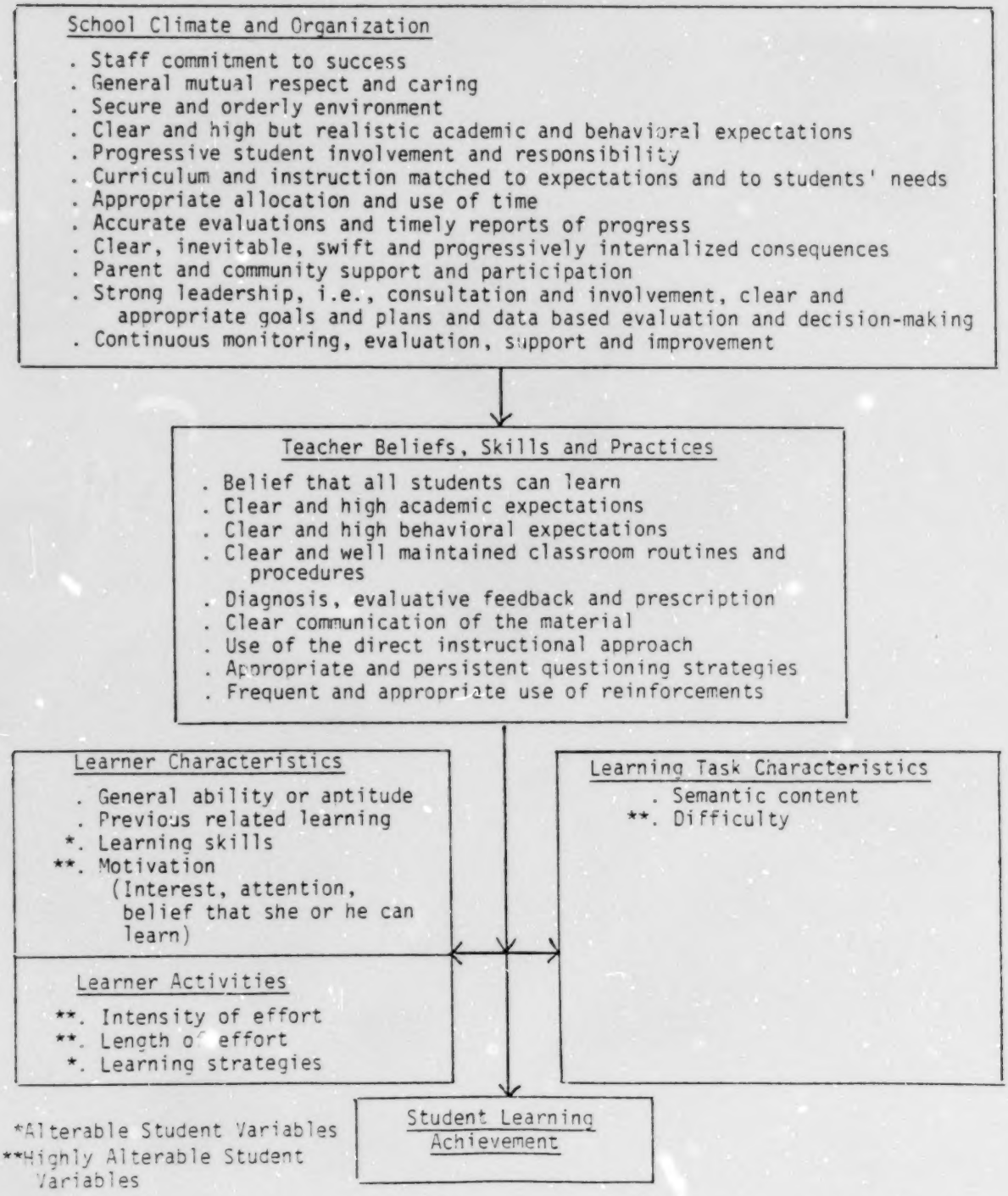
Coleman may have been at least partially correct. But more recent research suggests that at least two of these factors, learning skills and motivation, are subject to powerful influence by the teacher and the school, and that combined high tech/high touch efforts may have the key to most effectively producing that essential influence.

The key characteristics of the learning task include its semantic content and its difficulty. The semantic content, what is to be learned, is something of a given if it is included in the required curriculum. But when we present the task and its prerequisites to the student, the difficulty of the task set before him or her at any given time is theoretically under the teacher's control. High tech can make that theoretical possibility of giving each learner appropriately challenging learning tasks into a cost-effective reality through its individualizing effects.

There are two critical errors that may be made in this matter of difficulty. The first is to have such low expectations for an individual or a group that we deny them access to more difficult learning tasks and thus keep them from having an opportunity to learn whole parts of the curriculum. The other is to cavalierly set tasks of a discouraging and impeding level of difficulty before students when we know they succeed best in the long run when consistently offered learning tasks on which they have a high rate of success. The resolution of this apparent dilemma rests upon the ability to diagnose the student's readiness for a new task while planning and prescribing learning in a sequence of steps of gradually ascending difficulty. Even today's best designed interactive drill and practice software can assist the teacher in this crucial area and tomorrow's tutorials, simulations and games will be able to do it better and more vividly.

Figure 1

Factors of Effective Schooling, Teaching and Learning


School Climate and Organization
. Staff commitment to success
. General mutual respect and caring
. Secure and orderly environment
. Clear and high but realistic academic and behavioral expectations
. Progressive student involvement and responsibility
. Curriculum and instruction matched to expectations and to students' needs
. Appropriate allocation and use of time
. Accurate evaluations and timely reports of progress
. Clear, inevitable, swift and progressively internalized consequences
. Parent and community support and participation
. Strong leadership, i.e., consultation and involvement, clear and appropriate goals and plans and data based evaluation and decision-making
. Continuous monitoring, evaluation, support and improvement
Teacher Beliefs, Skills and Practices
. Belief that all students can learn
. Clear and high academic expectations
. Clear and high behavioral expectations
. Clear and well maintained classroom routines and procedures
. Diagnosis, evaluative feedback and prescription
. Clear communication of the material
. Use of the direct instructional approach
. Appropriate and persistent questioning strategies
. Frequent and appropriate use of reinforcements
Learner Characteristics
. General ability or aptitude
. Previous related learning
*. Learning skills
**. Motivation (Interest, attention, belief that she or he can learn)
Learning Task Characteristics
. Semantic content
**. Difficulty
Learner Activities
**. Intensity of effort
**. Length of effort
*. Learning strategies
Student Learning Achievement
*Alterable Student Variables
**Highly Alterable Student Variables

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The final set of learning factors are the activities of the learner. These consist of the intensity and length of the effort to learn and the learning strategies employed. Of these three, the first two are very much under the control of the learner and the influence of the school. The final factor, learning strategies employed, are also alterable but on a longer timeline.

If there are two key elements at the heart of the matter of school and classroom effectiveness, it is the factors of intensity and length of student effort to learn. To the extent that any other factor in the classroom or the school influences these two positively, they will contribute to higher achievement, all things else being equal. The individualization of instruction by high tech combined with ever more sophisticated adaptive reinforcers seem destined to help students remain engaged in the task of learning longer and with more sustained effort than is currently the case in typical classrooms characterized by Goodlad (1983) and others as places where teachers still mostly put out information aimed at the middle of the class with little student activity and little encouragement.

Factors of Effective Teaching

My review and analyses of the literature along with my work with principals and teachers in the Portland school system suggests that there are nine major factors of effective teaching over and above those elements that may be assumed to be present such as knowledge by the teacher of the subject matter to be learned. These key skills and practices which are again found in Figure 1 are:

1. Belief that all students can learn;

2. Clear and high academic expectations that reflect the curriculum adopted by the District (and which include coverage of the goals to be tested) but which are sequenced so that each student experiences a high rate of success;

3. Clear and high behavioral expectations (rules) and consistent enforcement;

4. Clear and well maintained classroom routines and procedures aimed at minimizing disruption and lost learning time;

5. Diagnosis of student learning progress and difficulties and provision of evaluative feedback including prescription of ways to maintain progress and overcome difficulties for example by regrouping;

6. Clear communication of the material to be learned;

7. Use of the direct instructional approach especially for lower order (convergent) cognitive objectives;

Again unified human/technology systems have the best chance of combining the appropriateness and vividness of the material presented with the emotional support that can only come from a believing, sympathetic human instructional coach to produce such an ideal teaching/learning environment.

Factors of Effective Schooling

It should be obvious that the separation of the factors of effectiveness into those of learning, teaching and schooling is artificial and to some extent

arbitrary. A school is a community with beliefs, rules, practices and relationships that interdependently affect the behavior of everyone in the school and ultimately influence the progress of each student in learning.

There are many formulations of the factors of effective schooling. I would summarize them simply as follows: good schools are places of purposeful caring, sharing, learning and growing where there are to be found the following elements:

1. Staff commitment to success of both students and colleagues;

2. General mutual respect and caring among all individuals and groups;

3. A secure and orderly environment;

4. Clear and high, but realistic, academic and behavioral expectations for students, teachers, programs and the school as a whole;

5. Increasing student involvement and progressive giving of responsibility and control over learning goals and activities to students as they mature;

6. Adaptation of curriculum and instruction to the academic expectations and to students' existing levels of academic preparation, motivation, learning style and special lacks, interests and strengths so that instruction is targeted and students are enthused, challenged and successful;

7. Appropriate allocation and use of time;

8. Accurate evaluations and timely reports of progress toward meeting expectations;

9. Clear, inevitable, swift and progressively-internalized consequences for meeting and exceeding expectations;

10. Parent and community support and participation;

11. Strong leadership, characterized by consultation and involvement of parents, students and staff, clear and appropriate plans and goals and data-based evaluation and decision-making;

12. Continuous monitoring, evaluation, support and improvement of all of the above.

Again, it is a wedding of technological capacity producing individualized cognitive communication, immediate responsive feedback and information about individual and group results combined with human planning and support that can best produce these factors of effectiveness at the school level as well as at the classroom and individual learner level.

Needed Research

The completion of the task of sorting out the best possible contributions of high tech and high touch approaches and factors to helping students learn most effectively will require a great deal of research. In general, experiments must be designed, performed and studied using both electronic and human means to deliver the effectiveness factors sketched above and the productivity

factors presented by Walberg. Initially, this will need to be done singly and then in combinations. Individual and group differences in response to various approaches will have to be studied. Out of this can emerge a heuristic science of schooling, teaching and learning that will consist of statements of the form: "For students with characteristics c_i in environment e_j pursuing objective o_k, the most cost-effective set and sequence of strategies is (s_l)." Lepper (1985) has conveyed well the urgency of getting about such research:

> In short, the technology is here, and the time for research is now. There seems to be relatively little disagreement that the influx of this new and powerful technology is likely to have more important effects on the lives and the social and psychological functioning of children than any other technological advance in the past century . . . There is considerable and quite heated debate, however, concerning the nature of effects that are liable to occur . . .
>
> In part, these disagreements reflect attention to different aspects of the wide variety of uses to which computers may be put in the lives of children. They also reflect, however, fundamental theoretical disagreements about basic empirical questions. At present, there is virtually no research concerning such issues. What little comparative research has been done on the effects of this technology is almost entirely focused on purely cognitive and instructional questions (Taylor, 1980). Yet it seems critical to examine the larger issues now, before this technology becomes such an integral part of our daily lives that it will be, as was the case with research on commercial television, too late to ask critical questions.

It will require an all-out collaboration by all members of the educational research community to meet the challenge of addressing these critical questions about how to best integrate emerging educational high technology into the enduringly essentially human enterprise of helping our youth grow and develop in ways desirable for them and for society. Partnerships must be formed and formed quickly between local and state school systems, education centers and laboratories, colleges and universities, private companies, and

teacher and administrator organizations. My own district stands ready to share and extend the research and evaluation efforts we have underway with any other members of Division of H or the educational research community at large. The work of our committees on university/school district collaboration, our directors of research network and clearinghouse, our annual awards process, and our annual program presentations are other means to establish and support these essential research partnerships.

Conclusion

Our anticipatory ecstasy at the promise of high tech it seems was premature but not foolish. The individualization possible through emergent technology does hold the promise not only to put before students the most appropriate learning tasks but also to assist creative teachers in their efforts to increase students' motivation, interest, attention, perception of personal competence and self-esteem leading to learning efforts of greater length and interacting on tasks of appropriate difficulty and ultimately to rapid mastery and growing satisfaction. With the help and support of enlightened teachers and administrators, high tech can hasten the advent of the evolution of those factors of effective learning, teaching and schooling that the last two decades of research on effective education have proven can indeed revolutionize our classrooms, our schools and our society. When this comes about our current agony of defeat will be transformed into the ecstasy of victory.

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